AIR FORCE SPECIAL OPERATIONS COMMAND

Air Commandos – Quiet Professionals

Update on the Transportable Plasma Waste to Energy System at Hurlburt Field

2010 ENVIRONMENT, ENERGY & SUSTAINABILITY - Symposium & Exhibition

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Report Documentation Page

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What is Plasma?

- **Plasma is an ionized gas that conducts electricity.**
- **The current releases large amounts of heat.**
- **Several technologies have been developed to use this source of heat which can reach temperatures from 10,000 to 20,000ºF.**
- **No fossil fuels**

PyroGenesis has been designing, manufacturing and continually improving its core technology.

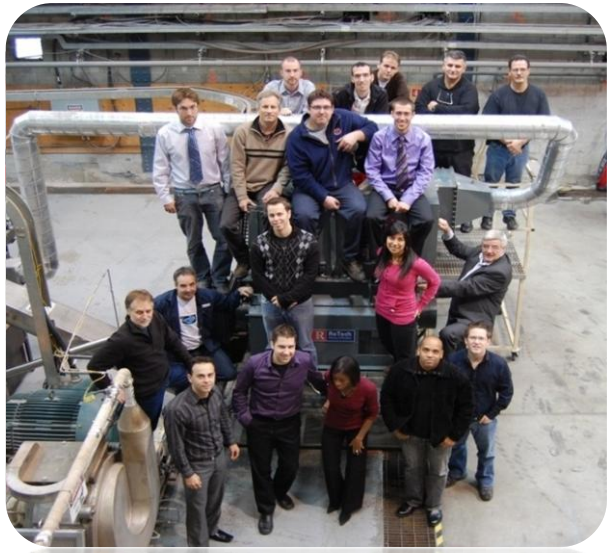
There are four states of matter			
Solid →	Liquid →	Gas →	Plasma
<32ºF	>32ºF	>212ºF	>10,000ºF
Ice	Water	Steam	Ionized Gas

As hot as the surface of the sun

PyroGenesis Canada?

- PyroGenesis was established in 1991
- A technology based company with 7 patents in 28 jurisdictions
- Design, development, fabrication and assembly of pilot scale and commercial systems
- Electrical, automation and process control capabilities
- Delivery of turn-key solutions

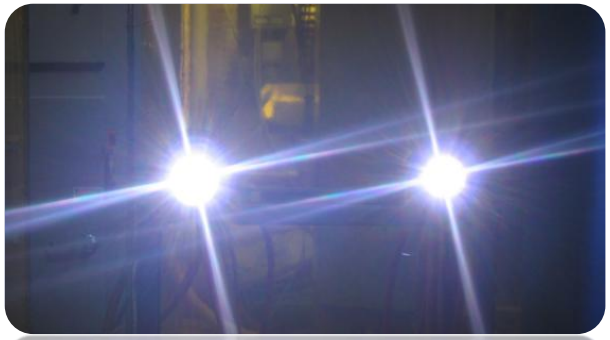
ISO 9001
QCERT
Certified quality system



50 employees including chemical, mechanical and electrical engineers and process technologists

From a Mere Idea to a Commercial Reality

- Plasma is traditionally an expensive technology for waste treatment.
- Identification of a niche market → Marine
  - Marine environment characterized by lack of space
    (most expensive real-estate in the world)
- Plasma allows for the development of small compact systems
- Marine expertise led to opportunities on “land-based” waste treatment



PyroGenesis' Unique Plasma Based Systems

Plasma Resource Recovery System – Designed as a Clean and Efficient Waste to Energy Solution

10.5 TPD Transportable System for Hurlburt Field AFB

Plasma Arc Waste Destruction System – Designed for Marine Industry requirements

To be installed on the US Navy's CVN 78 Air Craft Carrier

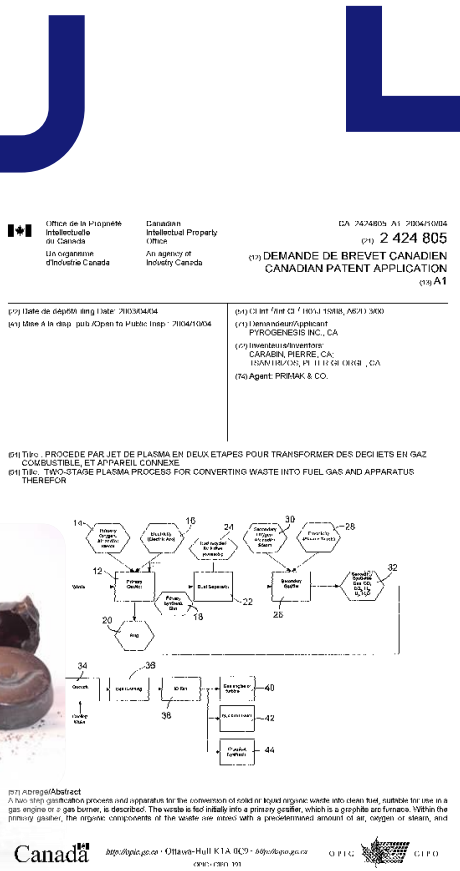
Installed on a Carnival Cruise Lines Ship

Plasma Resource Recovery System (PRRS)

Patented two stage process

Vitrification

Inorganic material is melted at 3,000°F to produce an inert slag that is safe for use as a construction material



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(71) Demandeur/Applicant:
PYROGENESIS INC., CA

(72) Inventeurs/Inventors:
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[illegible], CA

(74) Agent: PRIMAK & CO.

(54) Titre : PROCEDE PAR JET DE PLASMA EN DEUX ETAPES POUR TRANSFORMER DES DECHETS EN GAZ COMBUSTIBLE, ET APPAREIL CONNEXE

(54) Title: TWO-STAGE PLASMA PROCESS FOR CONVERTING WASTE INTO FUEL GAS AND APPARATUS THEREFOR

(57) Abrégé/Abstract

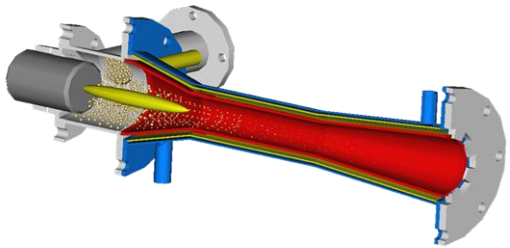
A two-stage gasification process and apparatus for the conversion of solid or liquid organic waste into clean fuel, suitable for use in a gas engine or a gas burner, is described. The waste is fed initially into a primary gasifier, which is a graphite arc furnace. Within the primary gasifier, the organic components of the waste are mixed with a predetermined amount of air, oxygen or steam, and

Canada http://opic.gc.ca · Ottawa-Hull K1A 0C9 · http://cipo.gc.ca OPIC CIPO

Gasification

~~Pyrolysis~~

Thermal conversion of organic matter into synthesis gas consisting primarily of CO and H_2 using a sub-stoichiometric amount of oxygen



Molten Metal Oxides

Thermal Shock to the Slag Produces Inert Aggregate

Plasma Arc Gasification & Recycling

Waste

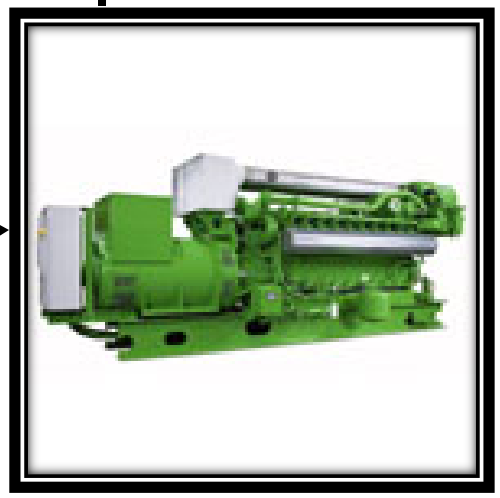
PRRS:
Plasma Waste to
Energy System

Recyclables

Electricity

Power to
Grid

Syngas



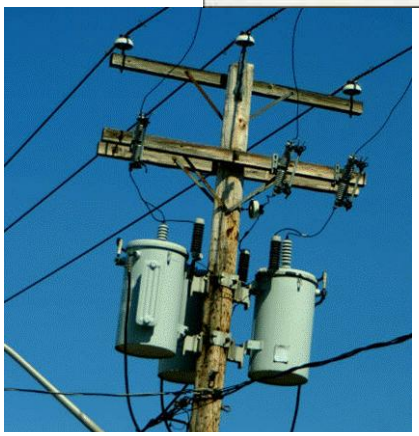
Jenbacher
JCS 312

PRRS is Designed to Process…

Hospital / Clinical

Municipal Waste

Construction waste



PCB's- Transformer oils

Fly Ash

Hazardous Chemical waste

Hazardous Chemical waste

Plasma Resource Recovery System (PRRS)- Animation

Plasma Resource Recovery System (PRRS)

Features
Energy Efficient → **NET ENERGY PRODUCER**
Robust and Flexible so that it can handle virtually **any** type of waste (hazardous and non-hazardous) without the need to pre-sort.
Clean Technology with no Secondary by-products requiring disposal
Compact so that smaller units can be designed to be **transportable**
Design to be safe and easy to operate (minimum man-power requirements)
Design to be a **low capital & operating cost** alternative to conventional waste management practices.
Scalable : 2 to 50 tons per day with possibility of scaling up to 240 TPD and beyond

Plasma Waste to Energy System

Pilot System

Plasma Torch

Technology

- System uses intense heat of plasma energy to gasify and vitrify virtually any type of waste
- Unit is a net energy producer and yields marketable by-products with no pollutants

The So What

- System allows on-site destruction of virtually any material eliminating disposal in landfills
- Relatively low capital/low operating cost alternative to conventional waste management practices
- Wide spread use in the US would reduce dependence on fossil fuels
- Designed to be mobile allowing deployment to clean up polluted sites or use in AOR to solve problems with open pit burning

Participants

- Sponsor: AFSOC/A7
- Industry Partner: PyroGenesis Inc. of Canada
- Contributors: OSD/CTO, AFSO21, Cdn Gov't, Gulf Power, AF/SG

Schedule

Issue RFP	11 Apr 08
Contract Award	6 Jun 08
Initial Planning Meeting w/ Contractor	9 Jun 08
Design/Permits for Facility/Infrastructure	30 Sep 09
Receive/Assemble Equipment	30 Dec 09
Developmental/Operational Testing	30 Mar 10
System Acceptance Decision	30 Jun 10

RDT&E Funding ($M)

	FY08	FY09	Total
CTO	1.7	2.0	3.7
AFSO21	2.0	0.0	2.0
Canada	2.0	0.0	0.8
AF/SG	0.0	0.8	0.8
GP	0.0	0.1	0.1
TOTAL	**4.5**	**2.9**	**7.4**

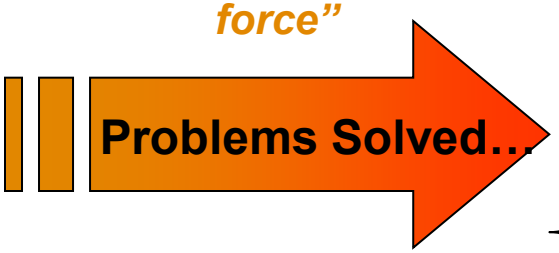
Benefits

- Eventually 100% recycling of all waste streams at Hurlburt
- O&M cost avoidance is estimated to be $0.7M per year
- Payback less than three years

Plasma Resource Recovery System (PRRS)

***PRRS* can safely and efficiently convert virtually any type of waste (hazardous & non-hazardous) into energy and useful products and is, in many instances, a net energy producer.**

"Be a more mobile, agile force"

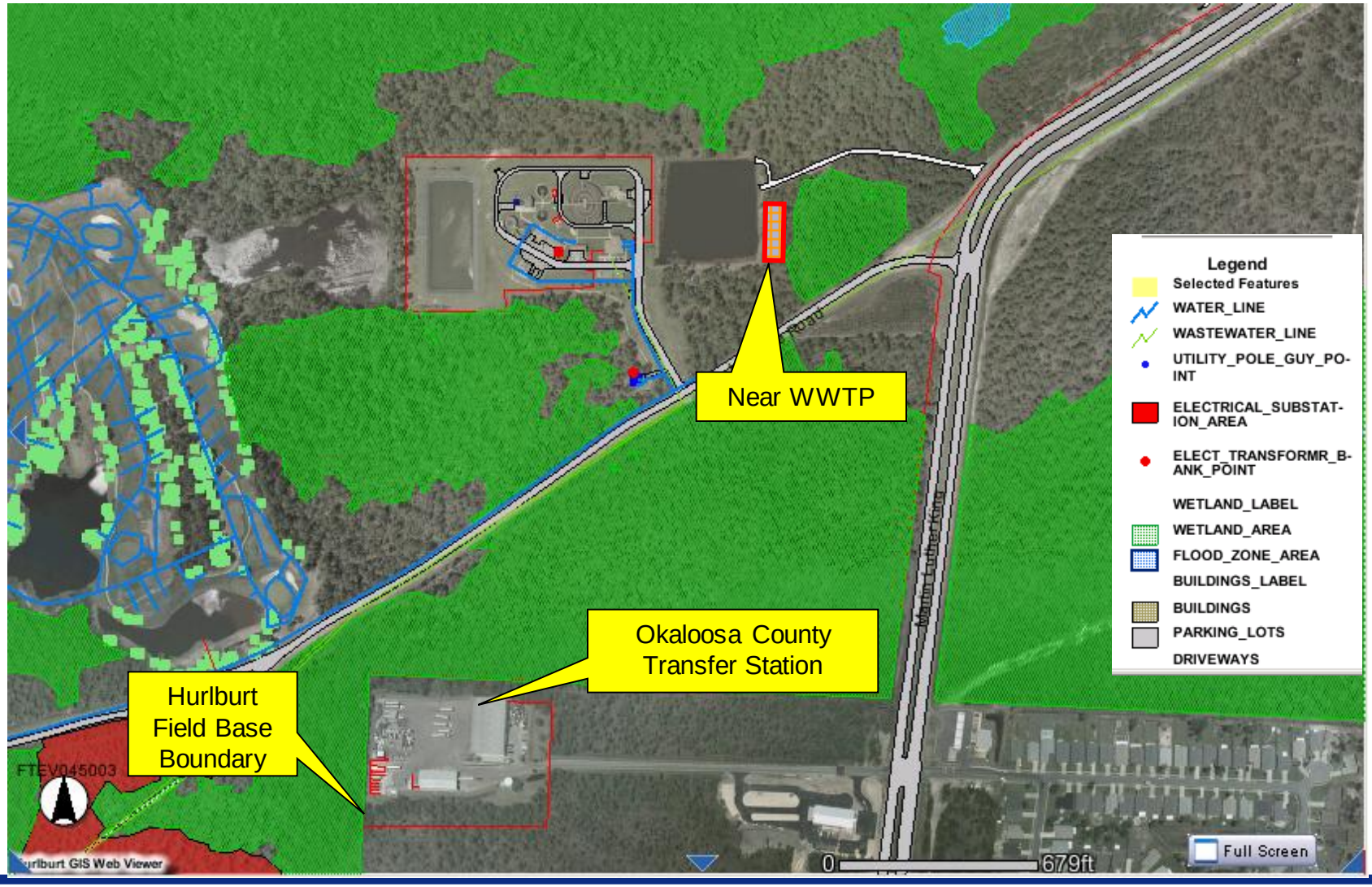


"Energy is now seen as a national issue"

"DoD is the single largest buyer of fuel in the US"

1. *The System can be designed to be **mobile**, allowing for a more **agile** and **autonomous** operation.*
2. *The PRRS allows for the **on-site destruction** of virtually any material, including chemical and biological waste.*
3. *PRRS could **reduce the US dependence on fossil fuels** with virtually no environmental impact.*
4. *The PRRS is a **low capital and operating cost** alternative to conventional waste management practices.*

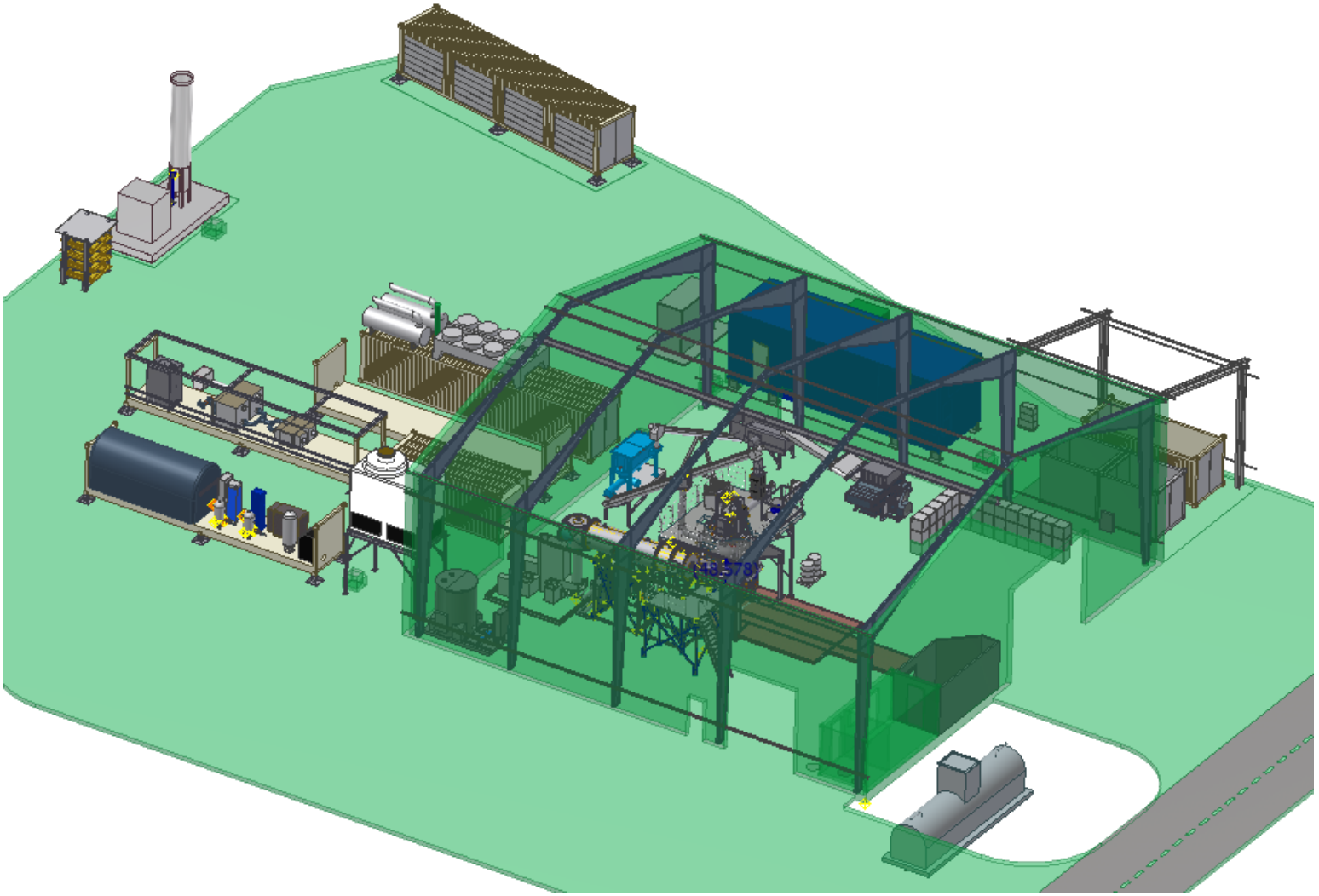
Plasma System Approved Site on Hurlburt Field



Environmental Permitting

- *Storm Water Permit received in March 2009*
- *RD&D Permit received in July 13, 2009*
- *3 tap permits (reuse, potable, force main)*
- *Air Construction Permit received on Oct. 1, 2009*
- *Hazardous Waste Treatability Study submitted in May 2010*

3D model of Hurlburt Field TPWES



Facility Overview During Construction

Electrical Conditioning Module

Waste Feeding overview

Shredder

Magnetic Metal Separator

Eddy Current Separator

Plasma Furnace and Eductor

Caustic Scrubber

H2S Scrubber

Cooling Water skid installation

Cooling water & Gas Cleaning skids

Gas Cleaning and Gas Engine (Top View)

Gas Cleaning, Gas Engine and Emergency Flare

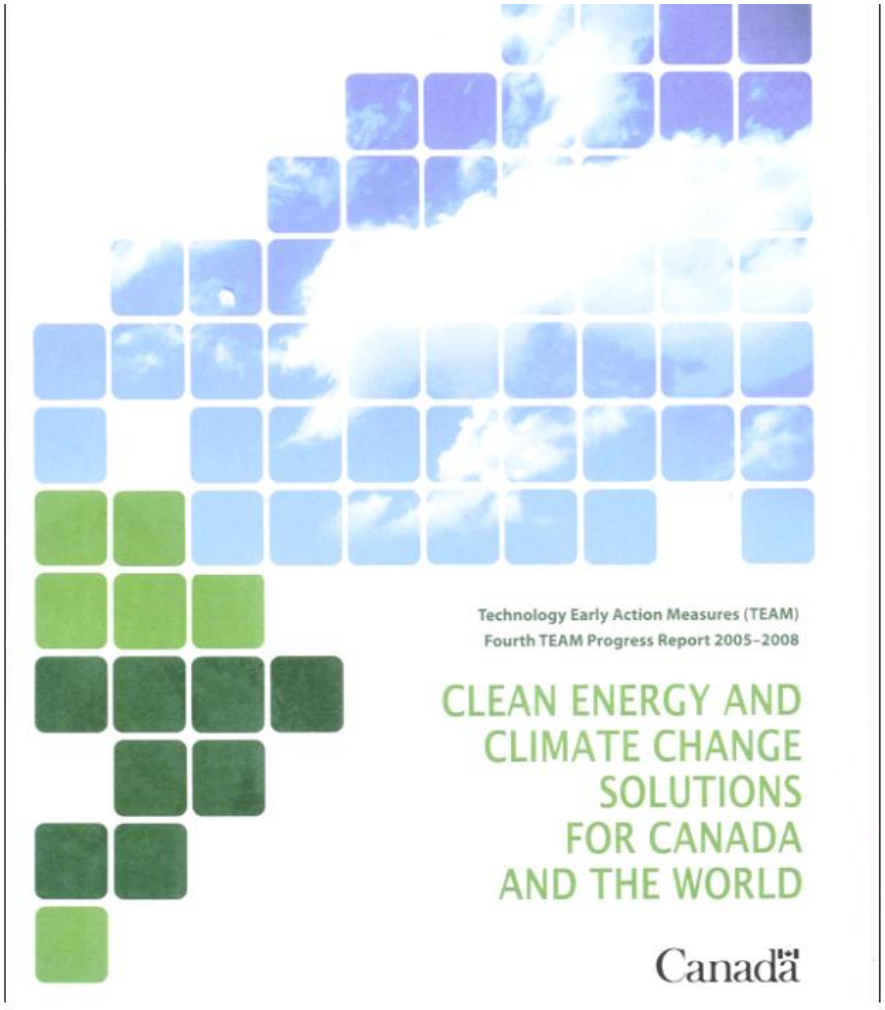
GE Jenbacher 12 Cylinder Internal Combustion Engine

GE Jenbacher IC Engine

Continuous Emissions Monitoring System

Human Machine Interface

Carbon Credits



INT-049 PyroGenesis Canada

Plasma resource recovery system turns waste into energy

In this project, PyroGenesis Canada will enhance its existing design towards commercial scale and demonstrate a 10 tonne-per-day plasma resource recovery system (PRRS) that turns waste into syngas, vitrified rock and metal. Syngas can be used to generate electricity and heat while the "glassy rock" can be used as an aggregate for construction and metals can be sold for recycling. This project will use a wide range of waste streams from the United States Military, including municipal solid waste, hazardous waste and bio-medical waste.

Greenhouse gas reduction:

- 83,037 t CO_2e per year
- 25.66 t CO_2e per tonne of waste processed

Partner:

- The United States Military

Summary

- *Hurlburt Plasma Waste to Energy System can:*
  - *Save tax payer dollars*
  - *Convert waste to energy, i.e. electrical and heat*
  - *Recover waste stream products*
  - *Reduce green house gas emissions*
  - *Divert waste from landfills*
  - *Help AFSOC exceed EO 13423/13514 mandates*
  - *Opens the door for future DoD and National applications by springboarding larger scale systems*
- *Help solve tough war fighter problems!*

Questions?